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Abstract

BURN-UP DETERMINATION OF NUCLEAR FUEL BY HIGH RESOLUTION GAMMA-SPECTROSCOPY

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The γ-radiation of fission products is used for burn-up determination of irradiated fuel-elements by a non-destructive method. If no information on the irradiation history (except an upper limit of a few years) is available or cannot be used for the interpretation of the measurements (a case which occurs practically during the inspection of IAEA-distributed fuel) only Cs^{137} can be used for total burn-up determination due to its 30 γ half-life. In addition a measurement of the 2.19 MeV line of Ce-Pr-144 (284 d half-life) is useful due to the low absorption corrections for this γ-energy and favourable diffusion behaviour of these fission products but the interpretation requires a knowledge of irradiation history. The measurement of Cs^{137} in the fission product spectrum is very difficult due to strong adjacent lines, and requires high γ-energy resolution. The measurement of the 2.19 MeV line of Pr-144 is also complicated in Pu-containing fuel due to neighbouring lines of Rh-106.

A high resolution γ-spectrometer is described and practical results are reported. The γ-spectrometer is based on the measurement of the Compton-scattering events in a Li-drifted semi-conductor detector. The principle of the Compton coincidence spectrometer - known since many years for scintillation detectors - is applied. This gives the advantage of a unique correspondence between γ-energy and the observed peak in the pulse-height distribution. By using the high resolution properties of a semi-conductor detector a f.w.h.m. of 18 keV nearly independent on the primary γ-energy has been achieved and further improvement is likely. For the quantitative determination of Cs^{137} a minimum cooling time of two weeks is

required. The spectrometer can be constructed in a very compact way (40 x 40 x 20 cm without electronics and auxiliary apparatus) and requires at the location of the fuel elements storage a collimator hole in the storage tank wall and a scanning machine for the fuel element itself.